THE NORTHERN VIRGINIA MINERAL CLUB INC

Crystals are the flowers of the Mineral Kingdom

The Mineral Newsletter

Meeting: February 24 Time: 7:45–9:00 p.m.

Long Branch Nature Center, 625 S. Carlin Springs Rd. Arlington, VA 22204

USGS Mineral Resources: Past, Present, and Future

February 24 Meeting

Our speaker at the February NVMC meeting will be Paul M. Young, the U.S. Geological Survey's Acting Associate Director for the Energy and Minerals and Environmental Health mission areas.

Paul has over 25 years experience working at USGS, where his career has included topographic and geological map compilation, systems development, information management, and the management of multidisciplinary science activities. For the last 3-1/2 years, he has served as Deputy Associate Director for Energy and Minerals and Environmental Health.

Paul has over a decade of experience teaching geographic information science at the continuing education and graduate levels for University of Maryland–Baltimore County and George Mason University.

Volume 55, No. 2
February 2014
You can explore our club website:
http://www.novamineralclub.org/

Northern Virginia Mineral Club members,

Please join our February 24 speaker, Mr. Paul Young, for dinner at the Olive Garden at 6 p.m.

Olive Garden, Baileys Cross Roads (across from Skyline Towers), 3548 South Jefferson St. (intersecting Leesburg Pike), Falls Church, VA
Phone: (703) 671-7507

Reservations are under Kathy Hrechka, Vice President, NVMC. Please RSVP to my cell at (703) 407-5393 or kshrechka@msn.com.

Previous Meeting Minutes

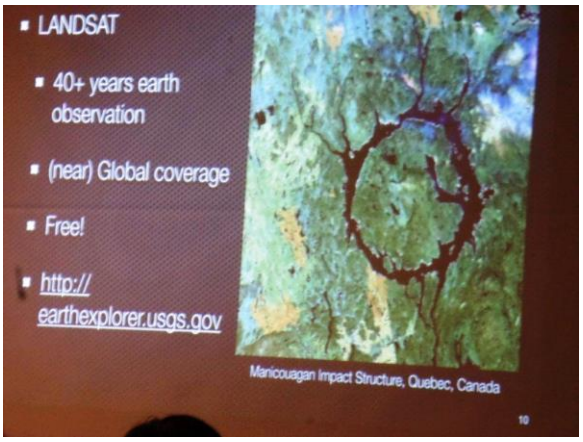
January 27, 2014

by Ti Meredith, Secretary

Vice-President Kathy Hrechka called the meeting to order at 7:50 p.m.

Dr. Michal J. Krimmer, Geospatial Studies Program Head and Assistant Professor at Northern Virginia Community College, kicked off the meeting with a presentation on geospatial

Dr. Michael Krimmer (left) making a presentation on geospatial technologies (right) at the February NVMC meeting. The slide shows a LANDSAT image of an impact crater in Canada. All photos: Sheryl Sims.



technologies. Lisa Diernisse recruited Dr. Krimmer for the presentation.

Dr. Krimmer has graciously posted his PowerPoint, along with its embedded videos and live URLs, making it available to NVMC club members. To access his presentation, go to www.nvcc.edu/home/mkrimmer or copy the URL to your browser bar.

Business Meeting

Past presidents were recognized—Rick Reiber, Wayne Sukow, and Barry Remer. Guests included Laura Mraz, Zackary Sacks, Jennette Baughan, and Dennis Hedrick. The door prize winners were Earl Smith, Bob Cooke, Bob Groves, Laura Mraz, David MacLean, and Sheryl Sims.

Club members received volunteer certificates of appreciation for contributing to the annual NVMC mineral show at George Mason University on November 22–24, 2013. Kathy Hrechka thanked Pat Flavin for taking care of the holiday dinner in December.

Treasurer Rick Reiber reported that the Fred Schaefermeyer Scholarship Fund has a total of $1,100. Dr. Lance Kearns of James Madison University nominated one of his students for a scholarship (see p. 3). The nominations will be further discussed at the February club meeting.

The club still has no new president, and Kathy Hrechka announced the need for a search committee. Pat Rehill, Sheryl Sims, and Lisa Diernisse volunteered (see p. 4).

Upcoming Events

This year's club mineral show at George Mason University is already being planned. The date under consideration is the weekend before Thanksgiving.

John Weidner reminded everyone of the open house at the Thin Section Lab at Northern Virginia Community College's Annandale Campus on February 8 and again on February 15. The January issue of *The Mineral Newsletter* has details and directions.

Dr. Lance Kearns is hosting the NVMC and other mineral clubs on February 22 at James Madison University (see p. 9 for details). Volunteers are needed for the event; to sign up, please go to http://vols.pt/MM2Nkp.

For other upcoming events, see p. 17 below.

Geology in the News

Douglas Brooks pointed out that there will be a curling event in the Sochi Olympics this year.

Dave Nanney displaying the certificate of appreciation he got for volunteering at the NVMC mineral show at George Mason University in November 2013.

Curling stones are made from granite quarried in the British Isles.

The *Washington Post* reported new research on the Grand Canyon, reviving debate about the canyon's age.

Kathy Hrechka and Sheryl Sims talked about a large blue diamond from the Cullinan Mine in Pretoria, South Africa.

NVMC Members

At our holiday party in December 2013, President Rick Reiber handed out appreciation certificates expressing thanks to our volunteers at the NVMC annual show at George Mason University in November 2013.

We invite the following members to come to the next club meeting to receive their certificates:

Jennifer Casper	Lois Dowell
Fran Ely	Phillip Fouts
Angela Goodhart	Becca Goodhart
Jeff Guerber	Michelle Harris
Darren Kimble	John Kress
Victoria Martin	Leslie Nanny
Thomas Pierce	Talaya Ridgley
Ken Rock	Beth Smith
Conrad Smith	Erika Suski
Tom Taaffe	Judy Winkler
Rebecca Winkler	Susan Von Struensee
Michaele Wyatt	

Kathy Hrechka, Vice-President

Fred Schaefermeyer Scholarship Award Nominee

by Dr. Lance Kearns

Editor's note: Kathy Hrechka, NVMC Vice-President, recently asked Dr. Lance Kearns, professor of geology at James Madison University, whether he had a student deserving of a $250 scholarship award for 2014. Here is his reply.

I recommend that NVMC members consider Brandon C. Euker, a geology student at James Madison University (JMU), for the Fred Schaefermeyer Scholarship award.

Keenly interested in minerals, Brandon was one of the top-scoring students in my Mineralogy course last year. What I was deeply impressed by his self-motivation.

Brandon became *very* interested in the new technology of three-dimensional printing. He studied it and he took a class at the JMU labs set up with 3D printers, then proceeded to "manufacture" sample models of the six crystal systems. He did a very nice job.

This semester, Brandon is in my very advanced course titled Laboratory Methods in Geology. The course involves intense instrumentation, including XRD, SEM, EDS, Raman, isotope ratios, and atomic absorption/emission.

Brandon is also in the JMU Student Honors Program. He has one of the higher grade point averages in the geology department.

I spoke with Brandon, and he would be willing to write an article for your newsletter on the use and workings of 3D printers. I think he would be a worthy scholarship recipient.

In Search of Our New Club President

by Pat Flavin

Our club has exhaustively searched for a new president to fill Rick Reiber's shoes. Rick has stepped down to fulfill other club obligations. For several years now, he has served both the NVMC and the Mineralogical Society of the District of Columbia (MSDC) as president, vice-president, treasurer, and secretary. He is currently serving as treasurer of the NVMC in tandem with Kenny Loveless and as secretary of the MSDC.

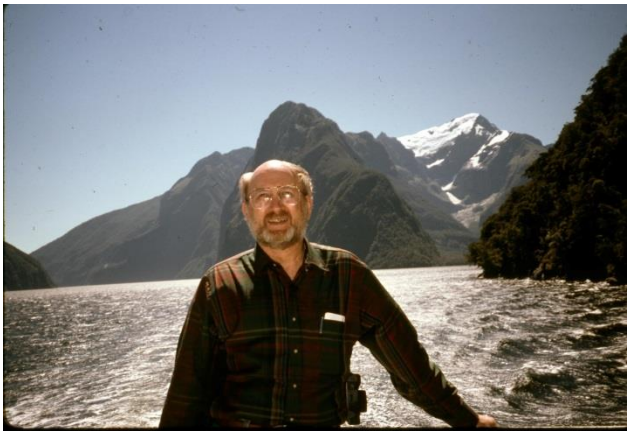
This is *your* opportunity to step forward and serve your fellow rockhounds as president of the NVMC! Know that if you serve you will be well supported by other NVMC officers as well as by club members.

Wayne Sukow has generously offered to serve, but only if he is begged—and only if no one else comes forward. (I think those were his exact words!)

Dr. Sukow, with a Ph.D. in chemical physics, is no stranger to our club. He is a past NVMC president and has made presentations on several fascinating mineral topics, including copper replacement agates and Lake Superior agates from Michigan's Copper Country. Wayne is a noted photographer of minerals, an award-winning collector and exhibitor, and an author of mineral and lapidary publications.

If no one else steps forward, then we will be very fortunate to have Wayne serve as our new club president. In accordance with club rules, however, we must try to have additional candidates for an election. If we fail to produce additional names, then we should use the next few years to foster an interest in others to serve as club president in the future.

Wolverine copper replacement agate.



Dr. Wayne Sukow in New Zealand (a Facebook photo).

Ancient Map Could Warn of Active Volcano

Thanks to Sue Marcus for the link!

About 9,000 years ago, an artist in what is now Turkey drew what could be the world's oldest known map, complete with a volcano erupting in the background. A recent discovery of lava rock indicates that the volcano might still be active. For more, go to: http://news.discovery.com/earth/ancient-map-could-warn-of-active-volcano-140113.htm

Help Wanted for Book Project

A former member of the mineral club in Rockville, MD, is writing a children's book about minerals. She is now living in Seattle, WA, and looking for local help.

She is hoping that a club member might show their collection to her 15-year-old grandson, Valentino LaVilla, and help him find specimens to photograph for her book. Valya lives in Falls Church and is very responsible. His father will accompany him to wherever you might be.

If interested, please contact Sara LaVilla by e-mail at sarlbobl7@att.net.

Fracking on the Chesapeake Bay

By Patricia Flavin, Vice-President, Mineralogical Society of the District of Columbia

A friend sent me a link to a Website last week that has shaken me. Coming events might affect the little coastal town of Cove Point, MD.

Calvert County

The Cove Point Lighthouse and community sit quietly along the western shore of the Chesapeake Bay in Calvert County. Located in southern Maryland, Calvert County sits astride a long and scenic coastal peninsula that terminates at the sleepy seasonal resort town of Solomons Island. It is located about an hour's drive from Washington, DC, and 40 minutes from Annapolis, MD.

The historic Patuxent River forms the county's western boundary. Route 4 (Pennsylvania Avenue) is the main thoroughfare. The area is dotted with farms, reminding you that this was once prime tobacco country. Aside from agriculture, the area supports a fishing, crabbing, and oyster industry, along with various recreational and boating facilities and some land trusts.

Calvert County has rich natural resources, including collecting sites. The famous Calvert Cliff Formation lines the western shoreline for dozens of miles. These fragile cliffs contain fossils from the Miocene Epoch that are 8 to 22 million years old. Shark teeth, shells, corals, animal bones, whale skeletons, and archeological artifacts are embedded in the soft marine clay.

Fracking Plans

This area could be threatened by the process known as fracking—hydraulic drilling to extract natural gas from fractured layers of shale deep within the Earth. Those layers have been unreachable with conventional mining technologies, but three-dimensional imaging helps determine the precise locations for drilling. Fracking then injects highly pressurized fluids into the shale, creating new channels within the rock from which natural gas is extracted at higher rates than usual (Meador 2014).

This is bad news. That part of the Chesapeake Bay is apparently full of shale gas "gold" that

Calvert Cliffs, Maryland.

can be tapped by fracking. Dominion Resources, the company that is pursuing offshore drilling, is billing the product as "clean natural gas," as though the process is smart, clean, and efficient. But offshore fracking is still a process of trial and error. For one thing, fracking can cause water and air pollution.

Potential Impacts

Moreover, Dominion is planning to build a huge $3.8-billion dollar facility offshore as well as on land. Noise pollution is anticipated to be so great that Dominion is proposing to build a 60-foot (6-story) wall three-quarters of a mile long for "sound abatement." The structure would become the highest landmark in an area known for its unspoiled natural beauty.

In addition, increases in shipping, more extensive pipelines, and higher vehicular traffic could devastate both scenery and wildlife. They could harm the local economy and natural resources.

Neighboring areas could also be affected. Noisy, polluting compressor stations might be required from Fairfax, VA, to Frederick, MD, to keep gas moving through pipelines. Residents of the small, rural town of Myersville, MD, are already fighting a 16,000-horsepower compressor station that Dominion wants to construct just a mile from the Myersville elementary school.

Blasting offshore for fracking cannot be beneficial for the treasured Calvert Cliffs, which also serve as coveted shoreline real estate. Cliffs collapse all the time in this region just because of their fragile structure. Climbing on them or digging into them is prohibited because they are so unstable and dangerous. Underwater blasting

might deliver a devastating blow to the area's fragile ecology (Brian 2012).

Protest Planned

The future of fracking has become the very scary present. Nothing in the process sounds good for the Western Shore. The goal is to extract shale gas at four times the amount used by Maryland on a daily basis and export it to Asia and India. Does this sound "foreign" to you?

If so, please check out my sources below and go to the links, including the You-Tube video (Trout and Tulkin 2014).

This is your opportunity to get involved:

WHEN: Thursday, February 20th, noon to 1:30 p.m.

WHERE: War Memorial Plaza, corner of North Gay St. and East Fayette St., Baltimore, MD 21202

WHY: We've turned what Dominion thought was a done deal into one of the biggest environmental fights our state has ever seen. As a key hearing unfolds in Baltimore—right under Governor O'Malley's eyes—it's time to show just how big, strong, and far-reaching our grassroots movement to stop the Cove Point project has become.

Sign up to stop Cove Point! Go to the Chesapeake Climate Action Network Website at http://org.salsalabs.com/o/423/p/salsa/web/common/public/signup?signup_page_KEY=7727#sthash.IgtVgqIp.dpuf

Sources

Brian, F. 2012. Fracking in Maryland: Proceed with caution. 18 April. Chesapeake Bay Action Plan. http://www.bayactionplan.com/2011/04/fracking-in-maryland-proceed-with-caution/.

Meador, A. 2014. Fracking opponents appeal to Annapolis to prevent export of shale gas at Cove Point. DC Media Group. 13 January. http://truthout.org/news/item/21182-fracking-opponents-appeal-to-annapolis-to-prevent-export-of-shale-gas-at-cove-point#.UuUTA0Wg3s8.email

Trout, K.; Tulkin, J. 2014. Stop fracked gas exports at Cove Point. Chesapeake Climate Action Network. 8 January. http://www.chesapeakeclimate.org/index.php?option=com_k2&view=item&id=3726:stop-fracked-gas-exports-at-cove-point&Itemid=18

Summer Trip Idea: Dino Dig in Wyoming

Thanks to Sue Marcus for the link!

Heading west this summer? You might want to consider digging for dinosaur bones in Wyoming's Bighorn Basin. The Wyoming Dinosaur Museum has a Dig for a Day program open to all ages. Check it out at the following links:
http://www.wyodino.org/dig-for-a-day/
http://www.tripadvisor.com/ShowUserReviews-g60564-d104137-r70518290-Wyoming_Dinosaur_Museum-Thermopolis_Wyoming.html

You Might Be a Rockhound If ...

Editor's note: The piece is adapted from The Cowtown Cutter *(newsletter of the Fort Worth Gem and Mineral Club), April 2013, p. 6.*

You think road cuts are built as tourist attractions.

The rock pile in your garage is over your head.

You gave rocks, tumblers, or rock tools last Christmas.

When someone says Franklin, you think of New Jersey, not Ben.

The bookshelves in your home hold more rocks than books—and the few books they hold are about rocks.

The first things you pack for a trip are a chisel and hammer.

On a trip to Europe, you're the only one looking at castle and cathedral walls through a pocket magnifier.

You gauge the success of your vacations in terms of the rocks you bring home.

Geo Trip to JMU and Shenandoah Caverns

by Kathy Hrechka, Vice-President

Having the winter blues, Patricia Flavin and I took a road trip to James Madison University (JMU) to visit Dr. Lance Kearns and the JMU Mineral Museum, which he designed.

Dr. Kearns introduced us to some newly acquired minerals, including a topaz crystal (in the photo at right) from Morefield Mine in Amelia, VA. The museum, built in 2007, has 550 spectacular and rare mineral specimens on display. The collection began in 1976 under the curation of Dr. Kearns. Photos of the minerals taken with stacking software are featured on the museum's Website at http://csm.jmu.edu/minerals/.

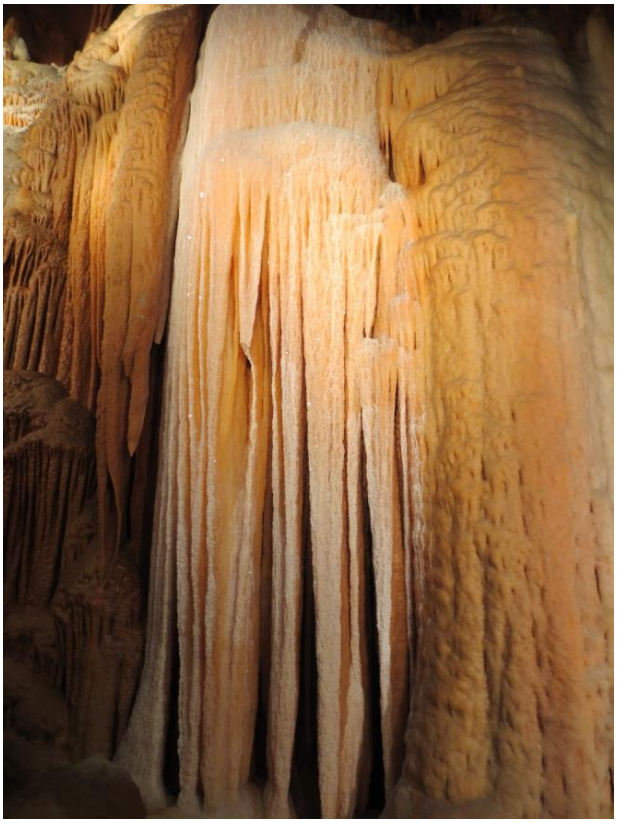
Check out these "two fine specimens"—not the topaz and turquoise from Virginia, but Patricia and Kathy admiring the Virginia Minerals case.

Patricia Flavin and Dr. Lance Kearns.

On our way home, we stopped at Shenandoah Caverns in Shenandoah, VA. We got our own personal tour, because winter is the slow season for cave visitors.

The cave was full of sound due to snow on the ground, providing a wet underground environment. Many of the stalactites were moist, creating an echo of dripping water throughout the cavern chambers.

The caverns' history began in 1884, when workers accidentally discovered the caves during construction of the Shenandoah Valley Railroad through the mountains. The area is underlain with limestone and has karst topography, forming caves throughout the valley. After being developed as Shenandoah Caverns in 1921, the caves were opened to the public as a tourist attraction.



Field Trip to James Madison University Mineral Museum

February 22, 9 a.m. until …

by Tom Tucker

Dr. Lance Kearns, professor of mineralogy at James Madison University (JMU) in Harrisonburg, VA, has again invited the Northern Virginia Mineral Club, Mineralogical Society of the District of Columbia, and Micromineralogists of National Capital Area to visit his laboratories and the JMU Mineral Museum. Our trip is planned for Saturday, February 22 (George Washington's birthday).

The trip is part of a tradition that Lance began a couple of decades ago, when he invited the Micromineralogists to his labs. Lance now extends the same courtesy on several weekends to many of the clubs in our region.

Over the years, Lance and his many supporters have assembled the finest mineral museum in Virginia. Thousands of high-quality specimens are displayed in a series of standing wall cases and center islands. A small alcove provides a dark area for a spectacular fluorescent mineral exhibition.

Lance will answer your mineralogical questions and use various analytical techniques to identify any unknown minerals you bring. Here's your chance to get that ugly black smudge from locality X identified!

For lunch, we will probably all go out to a local pizza establishment and then visit the scanning electron microscope (SEM) facilities across campus in the afternoon. If you have specimens too small for conventional analysis, we can work with the SEM and X-ray spectrometer to get them identified. So bring your little unknowns along!

If you are unsure about attending, talk with club members who have been to the labs in previous years. They will tell you that this is an opportunity not to be missed.

Lance will have various donated mineral specimens, including micromounts, for you to choose from, displayed on various counter tops. They will either be priced very reasonably or available in exchange for a fair donation. These aren't giveaways, so don't be cheap! There might also be a selection of geology and mineralogy books.

The lab will have plenty of student microscopes for you to use. Treat them as you would your own. Lance also has used binocular stereo microscopes for sale, hopefully to micromounters who will put them to good use.

The geology labs at JMU are about a 2-1/2-hour drive from the Beltway. Take I–66 west (toward Front Royal) for 65 miles to the junction with I–81. Go left (south, toward Roanoke) on I–81 for about 55 miles. At exit 245, leave the Interstate and go right on Port Republic Road. Go almost a mile to High Street and turn right. Continue north on High Street about a half mile to Cantrell Avenue, and turn left into the campus parking area at Memorial Hall. Because it's a Saturday, parking permits won't be needed.

To find the geology labs in Memorial Hall, just follow the signs. When you get to the right area, the room we're in should be obvious.

We usually pass the hat for donations to help defray the cost of mineralogy department activities and to reimburse Lance for getting us breakfast rolls and coffee.

I'd like to get a head count to Lance by Thursday, February 20. If you're planning on coming, please send an e-mail to Tom Tucker at threedogtom@earthlink.net to let me know.

Thornton Gap: How Did It Get There?

by Hutch Brown, Editor

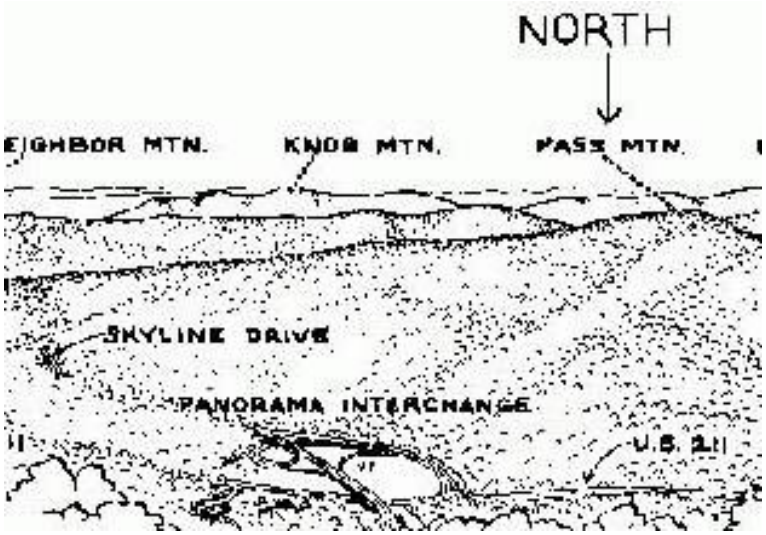
As a Boy Scout, I remember freezing one night while on a weeklong backpacking trip on the Appalachian Trail in Virginia's Shenandoah National Park. We were camped in a gap—it might have been Thornton Gap—and a cold wind howled through the gap all night long.

Ever since then, I believed that wind somehow formed those gaps in the Blue Ridge Mountains. That fierce wind convinced me—and what else could it be? They're called wind gaps, after all, and the gap was completely dry.

Was I wrong?

Location

Thornton Gap is located where Skyline Drive intersects U.S. Route 211, which connects Sperryville with Luray, VA. Nearby elevations range from 3,514 feet at Mary's Rock to the south, to 2,460 feet at Thornton Gap, to 3,052 feet at Pass Mountain to the north. The gap separates different drainage basins by less than a mile: Pass Run to the west, part of the Potomac River basin; and the Thornton River to the east, one of the headwaters of the Rappahannock River.



View from Mary's Rock. Thornton Gap is at Panorama Interchange between Skyline Drive and U.S. 211. Pass Mountain is to the north (upper right). Source: NPS n.d.

Thornton Gap. Photo: National Park Service.

The Blue Ridge Mountains contain some very old rocks. Mary's Rock, just south of Thornton Gap, is made up of granodiorite (like granite, but with more plagioclase feldspar and less alkali feldspar). Granodiorite is one of the Grenville basement rocks exposed in the Blue Ridge. The Grenville rocks underlie the western part of the state, with origins more than a billion years ago.

Pass Mountain, just to the north of Thornton Gap, is made up of Catoctin greenstone, which is not nearly as old, but still far older than most of Virginia's rocks. Catoctin greenstone, a metabasalt, originated from lava flows at the time of continental rifting about 570 million years ago when the Iapetan Ocean began to form, precursor to the Atlantic. The Catoctin lavas flowed over the Grenville rocks, forming a layer of basalt.

Thornton Gap happens to lie on a fault line right between them. The Catoctin greenstone and the Pedlar massif of Grenville rocks are separated in many places by a thin layer of metamorphosed sedimentary rock called the Swift Run Formation (fig. 1), but it is absent at Thornton Gap.

A Simple Answer?

Geologists are uncertain why and how gaps form, but most associate drainage with slope, uplift, and gravity. Gaps tend to form where there are faults, fractures, joints, and other weaknesses in the rock—potential points of

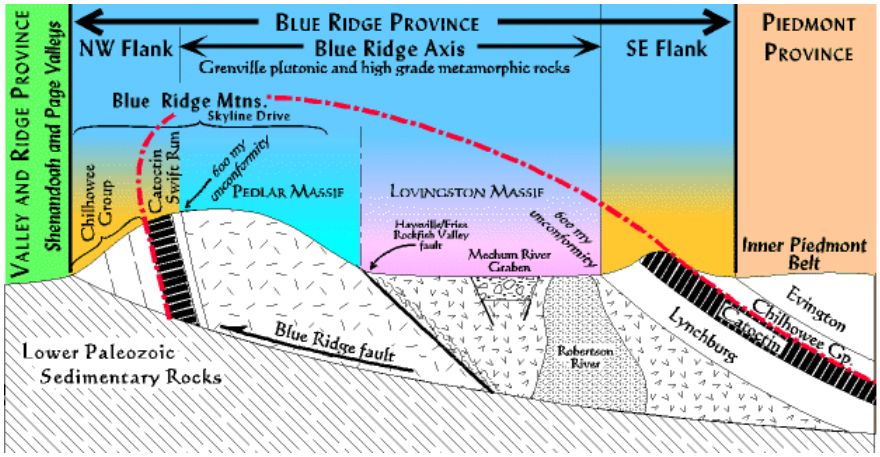


Figure 1—*The Blue Ridge thrust fault and overturned anticline. The Blue Ridge Province contains not only the Grenville granitoids, but also a suite of rocks associated with the opening of the Iapetus Ocean about 570 million years ago, such as Catoctin greenstone (metamorphosed basalt) and Weverton quartzite (a member of the Chilhowee group of metamorphic rocks). Source: Fichter and Baedke (1999).*

erosion. Given the fault line between two rock formations, Thornton Gap is one such point.

Scientists prefer simplicity. Given two equally cogent explanations, they will tend to choose the simpler one.

Accordingly, one source argues that Thornton Gap is exactly what it appears to be (Southworth 2013). Erosional forces such as wind, ice, and rain have ground away at the fault line between Catoctin greenstone and Grenville granodiorite, forming a saddle between the peaks to the north and south. In time, the Thornton River might even erode through the gap and capture the Potomac tributaries to the west.

But geology is not always simple. Other authors disagree (Fichter and Baedke 1999), and they have an intriguing tale to tell. Before getting to that story, it is time to dispel a myth.

Potomac River Myth

Recognizing the great age of the rocks, some have postulated that the Appalachian Mountains originated more than 300 million years ago when proto-Africa collided with proto-North America in a great mountain-building event known as the Alleghanian orogeny. According to one source, for example, the Potomac River's water gap at Harpers Ferry, WV, "was formed about 360 million years ago, when the Potomac River began cutting through the Appalachian Mountains" (NPS 2013).

Can that be? Another source has calculated that Mt. Everest, based on its rate of erosion, would completely erode away in less than 90 million years, all else being equal (Schimmrich 2013). Yet another source has stated that even the tallest mountains erode away in about 20 million years (Fichter and Baedke 1999).

Assuming that they are correct, it takes a major mountain chain less than 100 million years to erode down to a plain after a mountain-building event ends. The Alleghanian orogeny ended about 250 million years ago, so the great Alleghanian mountain chain that once covered our area is long since gone. What is now Virginia would have eroded down to a peneplain—a flat and featureless plain tilted slightly to the west, the orientation of the ancient Alleghanian Mountains in our area.

By about 230 million years ago, during the Triassic Period, rifting was beginning as the supercontinent Pangaea split apart, forming the Atlantic Ocean. Rifting would have tilted the land eastward toward the widening ocean, but only where the Triassic rift valleys formed in what is now Virginia's Piedmont and Coastal Plain.

The land to the west, though a peneplain, would have retained the westward tilt of the ancient Alleghanian Mountains. The rivers would have been slow and meandering, much as they are on the Coastal Plain today, and they would have drained west into the continental interior, like the Ohio River today.

In fact, Virginia's New River, with its westerly course, might be a relic of the period before Triassic rifting. The Potomac River as we know it today did not exist, nor did the water gap at Harpers Ferry. Both resulted from more recent geological processes.

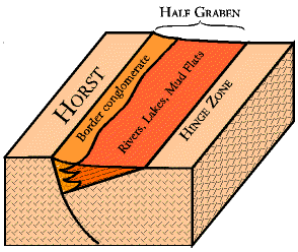
Triassic Rift Valleys

So what created the Potomac River basin, with its easterly orientation—and with tributaries reaching into the Valley and Ridge and beyond (fig. 2)?

The answer is unclear. But the geology of our area following Atlantic rifting points to a possibility.

During Atlantic rifting, a hot spot of magma formed under the continental crust of the Pangaea supercontinent. The brittle overlying crust began to dome and break, reactivating ancient weak points in the rock—old sutures and fault lines between proto-North America and proto-Africa.

Huge blocks of rock dropped down along faults, forming enormous walls known as horsts (from the German word for eyrie). The horsts loomed over a series of deep rift valleys (or graben, from the German word for trench), much like the Great Rift Valley in East Africa today.



At the axial (main) break in the continental crust, a full graben formed, with horsts on both sides. Continental doming and rifting also created a series of parallel half-grabens, with horsts on one side, the blocks of rock dropping down a fault in one valley wall as if on a hinge.

As the axial rift filled with seawater, the Atlantic Ocean began to form, much like the Red Sea today. With the continents pulling apart and the ocean spreading, the axial rift was buried on the edge of the continental shelf (fig. 3). The parallel half-grabens formed great basins that gradually filled with sediments; some are buried today under coastal sediments, but the ones in the Piedmont Province are exposed.

Great Rift Valley in East Africa. Note lake margins and beach in upper left, horst in upper right. Facing south, the Culpeper Basin might have looked similar about 220 million years ago. Photo: Hutch Brown.

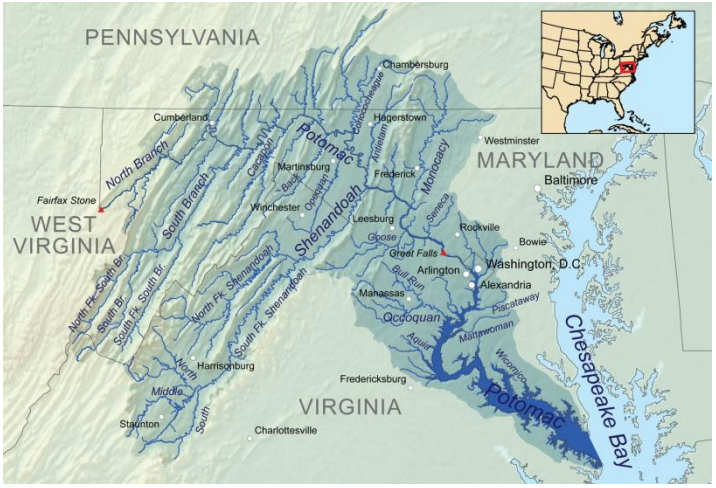


Figure 2—*Potomac River basin. The basin has two striking features: like other rivers feeding into the Chesapeake Bay, the Potomac generally flows from northwest to southeast; and its longest tributaries flow parallel to the orientation of the region's valleys and ridges from southwest to northeast. Source: Wikipedia.*

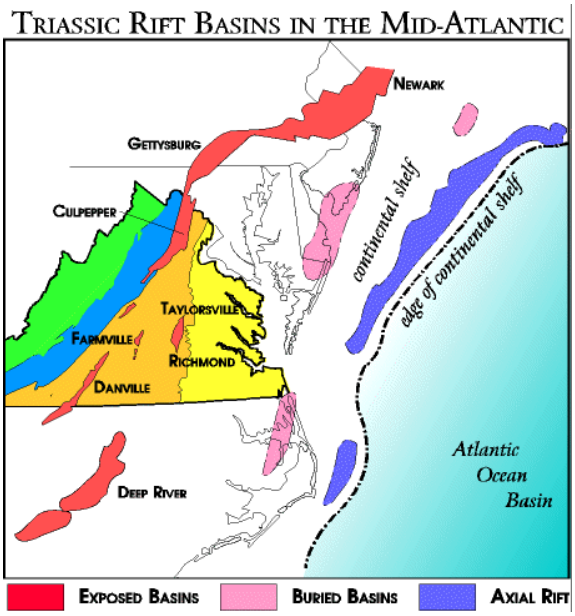


Figure 3—*The axial rift that formed the Atlantic Ocean is now buried on the edge of the continental shelf (blue). The parallel half-grabens are buried on the Coastal Plain (pink) but exposed in the Piedmont Province (red). Source: Fichter and Baedke (1999).*

By about 220 million years ago, what is now northern Virginia had developed a continental divide. The eastern edge of the Blue Ridge Province, from what is now Catoctin Mountain in Maryland to Bull Run Mountain in Virginia, loomed over the great rift valley we know today as Culpeper Basin (fig. 3), with drainage to the east into the Atlantic. To the west, a gentle plain took meandering rivers westward into the continental interior.

Culpeper Basin reaches from Frederick, MD, to 40 miles southwest of Manassas, VA. Even while it was forming, it was already eroding (fig. 4). Rivers and lakes took shape in the basin, depositing gravels, sands, and silts that are visible today as conglomerates, sandstones, siltstones, and other sedimentary rocks. A main river drained the basin, with headwaters to the northeast and southwest, at both heads of the basin. The river was likely braided, with a gentle slope and an outlet to the east.

That river was the forerunner of the Potomac. But how did it get over the horst, reaching into the Blue Ridge Province to the west? And how did the Potomac subsequently send its tributaries snaking southwest through the Valley and Ridge Province into the Thornton Gap drainage?

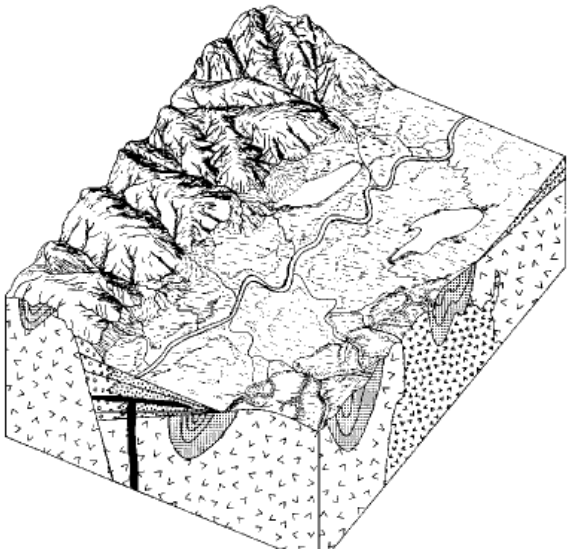


Figure 4—*Schematic cross-section of Culpeper Basin about 200 million years ago. The basin gradually filled with sediments eroded from the horst and carried in by the river that drained the basin. The Vs indicate bedrock; the black bars are a dike and lava flow; the dots on the right indicate igneous plutonic rock . Source: Fichter and Baedke (1999).*

Point of Rocks in Maryland marks the Potomac River's water gap through Catoctin Mountain. Source: Wikipedia.

Headward Erosion

The first obstacle was the horst that is today Catoctin Mountain. The main parts of the proto-Potomac River flowed parallel to the horst, but we know from alluvial fans in Culpeper Basin that the sides of the horst were incised by rapidly downcutting streams that fed the main river system (fig. 4).

One of those streams was at what is today Point of Rocks, the Potomac water gap through Catoctin Mountain. The horst there marked a divide between a rapid stream running down the rock face to the east and a slower stream draining the gentle plain to the west.

In a process called headward erosion, a stream gradually extends its channel above its point of origin. Over time, the stream cutting down through the steep eastern face of the horst would have formed a deeper channel than the slow-moving stream draining the plain to the west.

Through headward erosion, the east-flowing stream would have intercepted the shallower channel to the west, capturing its flow and sending its waters to the east. Continued downcutting through the horst then formed a water gap for a proto-Potomac River that now extended its basin to the west.

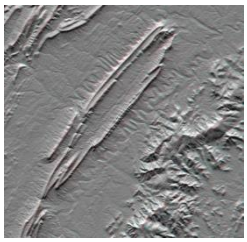
Through similar processes of headward erosion and stream capture, the other major river systems in our area—the ones draining into the Chesapeake Bay, such as the Rappahannock and James—also extended their basins westward. As

the horst eroded and Culpeper Basin filled with its sediments, the landforms in our area gradually disappeared, leaving a gentle plain now tilting toward the Atlantic (except for the New River and southwestern Virginia, which still tilt west).

Rejuvenation

Within the past 45 million years, a gradual uplift in the interior mid-Atlantic region has further tilted much of our area to the east. Known as Rejuvenation, its cause is uncertain; one hypothesis is continental arching due to mantle migration as sediments washed into the sea, lightening the continent and floating it upward while weighing down the ocean floor.

As the land rose and the slope steepened, the streams flowed faster and cut deeper. The softer sedimentary rocks, such as shale and limestone, eroded more rapidly, forming valleys trending northeast to southwest. Between them were ridges of more erosion-resistant rock, such as Grenville granodiorite, Catoctin greenstone, and sandstones to the west, including the sandstone that forms Massanutten Mountain. The ridges and valleys lie parallel to each other due to folding and faulting during the Alleghanian orogeny.



Massanutten Mountain.

At first, the rivers were roughly the same size, on the same parallel course toward the Atlantic, cutting down at about the same rate. Where the rivers crossed harder bedrock, such as the Grenville rocks, they cut gaps toward the Atlantic (fig. 5). At Thornton Gap, a branch of the Rappahannock River cut through the rising Blue Ridge at the fault line between granodiorite and Catoctin greenstone, probably because the contact zone was structurally weaker than other points in the rock and more easily eroded.

Accordingly, a single stream once flowed eastward through Thornton Gap, feeding the Rappahannock River. The same stream cut gaps through Massanutten Mountain to the west, such as Newmarket Gap, which conceivably aligns with Thornton Gap. The headwaters of the Rappahannock, like those of the Potomac, once extended across the Blue Ridge into the Valley and Ridge Province and perhaps beyond.

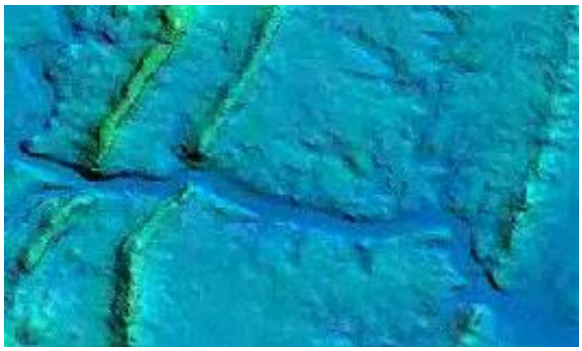


Figure 5—*Potomac River water gaps through the Blue Ridge, from left to right, at Harpers Ferry, South Mountain, and Catoctin Mountain. Source: GMU (2013).*

Stream Piracy

So what happened? Why is Thornton Gap now a wind gap instead of a water gap?

The softer the bedrock, the faster a stream can cut down through it. The downcutting potential of the stream is limited by the hardness of the ridges it cuts through and the absence of faults.

The Potomac River has three water gaps through the Blue Ridge Province—one through Catoctin Mountain and two more on the west limb of the Blue Ridge anticline at Harpers Ferry and South Mountain (fig. 5). The Potomac was apparently able to cut a deeper channel through the Blue Ridge Province than the Rappahannock tributaries could.

Why is unclear. It might have to do with a greater volume of water in the Potomac or with

View of the Potomac Watergap from Jefferson Rock, *a painting by Ferdinand Richardt (1857). The view is to the east, at the juncture of the Shenandoah and Potomac Rivers, with Harpers Ferry in the foreground. The water gap through South Mountain is visible in the distance. Source: Fennell (2013).*

weaknesses in the rock underlying its water gaps, such as faults, folds, fractures, and joints.

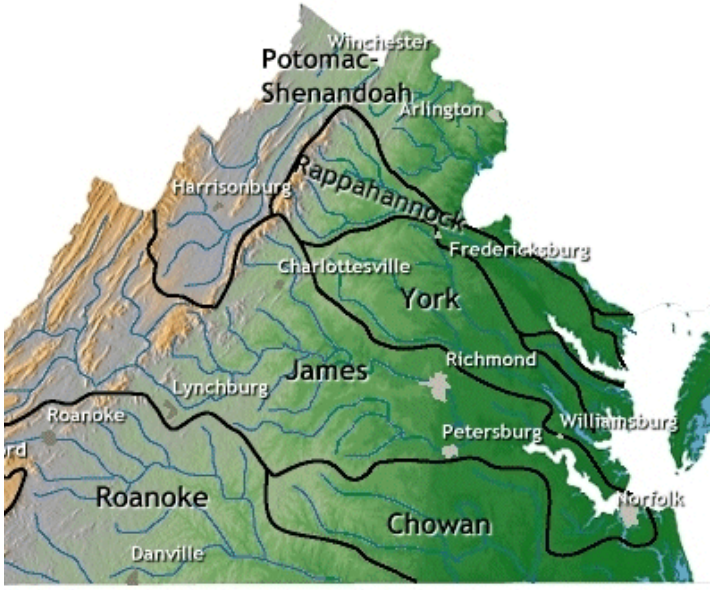
The deeper a stream's channel, the farther it can push its valley uphill above its original source. As the Potomac and its tributaries cut deeper into the bedrock, they extended their reach southwestward through headward erosion, deepening valleys along the parallel ridgelines.

In particular, the Shenandoah River worked its way up the western side of the Blue Ridge (fig. 6). As it intercepted the southeast-flowing Rappahannock tributaries, it brought them into its deeper channel. The tributaries followed a new course into the Potomac, adding to its volume and thereby increasing its downcutting capacity.

Over millions of years, the South Fork Shenandoah River gradually worked its way up Page Valley between the Blue Ridge and Massanutten Mountain to the west, capturing streams as it went. As a result, downcutting stopped at Thornton Gap. As the land continued to rise, a new watershed boundary line formed at the gap between the Potomac and Rappahannock basins. The water gap remained, but today it carries nothing but wind.

An Ongoing Process?

Not all scientists agree that the Thornton River once extended into the Valley and Ridge Province, carving Thornton Gap. Erosional processes at the fault line between Catoctin greenstone and Grenville granodiorite might suffice to explain



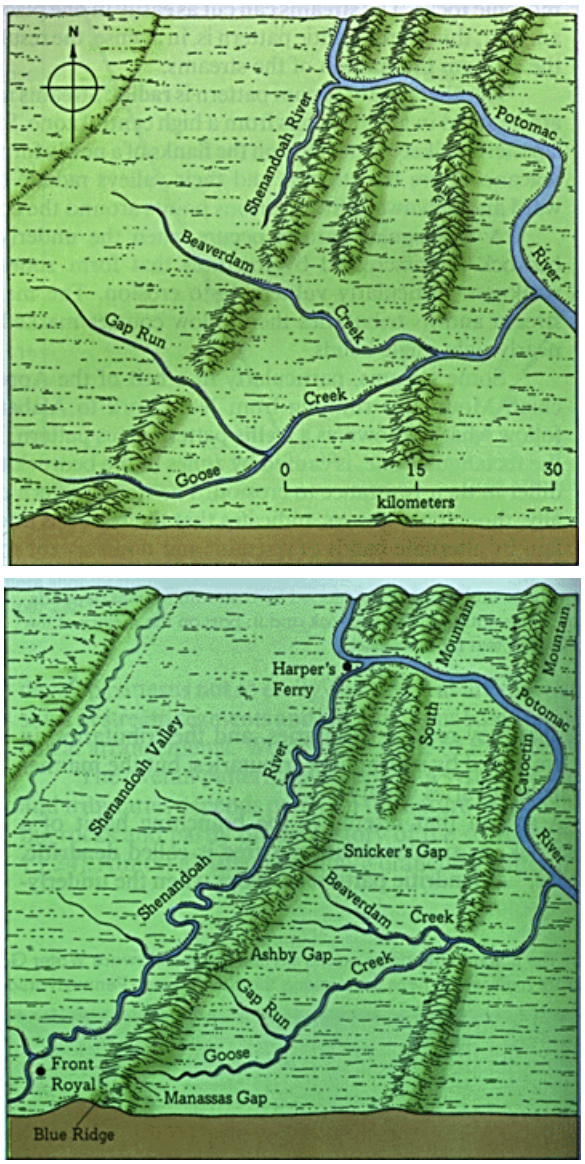


Figure 6—*Before (above) and after (below) images of Shenandoah River stream piracy through headward erosion on the west side of the Blue Ridge, forming a series of wind gaps in the Blue Ridge. Source: Judson and Kauffman (1990).*

the formation of Thornton Gap without the need for river action.

But the stream piracy theory is certainly plausible, and it would explain a great deal, such as the apparent alignment of Thornton Gap through the Blue Ridge with gaps through Massanutten Mountain to the west. By eroding its way up the parallel valleys in the Valley and Ridge Province, the Shenandoah River apparently captured all of the Rappahannock headwaters. A series of

wind gaps resulted in the Blue Ridge, ranging from Snicker's Gap, to Thornton Gap, to Rockfish Gap.

The process is still continuing. Could the headwaters of the James River be next?

Acknowledgments

Thanks to Scott Southworth of the U.S. Geological Survey for reviewing and commenting on the article and for providing key sources. The author is solely responsible for any errors.

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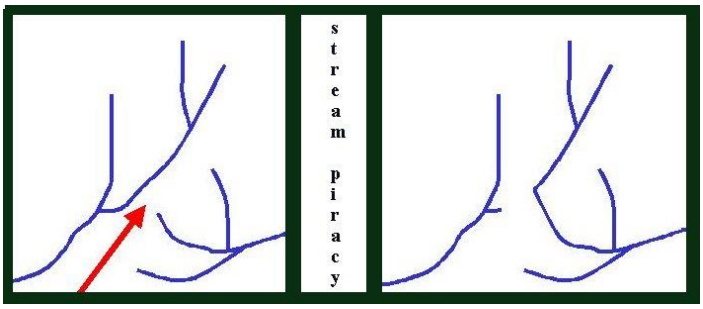

Upcoming Events
(of interest in the mid-Atlantic region)

January 30–February 16
Tucson 22nd Street Show
Minerals, fossils, dinosaurs, meteorites, gems, and jewelry; 60,000 square feet of exhibitor space, 180 dealers
Corner of I–10 and 22nd Street, Tucson, AZ

February 15–16
21st Annual James Campbell Memorial Gem, Mineral, and Fossil Show and Sale
Capital District Mineral Club and the New York State Academy of Mineralogy, New York State Museum, Empire State Plaza on Madison Avenue, Albany, NY

March 1–2
51st Annual Gem, Mineral and Fossil Show
Delaware Mineralogical Society
Sat. 10–6, Sun. 11–5; admission: $6
Delaware Technical and Community College, 400 Stanton-Christiana Rd, Newark, DE (exit 4B off I–95)

March 8
24th Annual Mineral, Jewelry & Fossil Show
Sat. 10–5
The Show Place Arena, 14900 Pennsylvania Ave., Upper Marlboro, MD
http://www.smrmc.org

March 15–16
Annual Gem Mineral and Fossil Show
Gem Lapidary and Mineral Society of Montgomery County
Sat. 10–6, Sun. 11–5; adult admission: $6
Montgomery County Fairgrounds, 16 Chestnut St., Gaithersburg, MD
http://www.glmsmc.com

March 22–23
45nd Annual Gem & Mineral Show
Che-Hanna Rock and Mineral Club, Athens Twp. Vol. Fire Hall, 211 Herrick Ave., Sayre, PA; Contact: Bob Mcguire (570/928-9238)
http://www.chehannarocks.com

March 29–30
64th Annual EFMLS Convention and Show
Philadelphia Mineralogical Society and Delaware Valley Paleontological Society, LuLu Temple, Plymouth Meeting, PA

April 11–13
NY/NJ Mineral, Fossil, Gem, and Jewelry Show
350–400 exhibitor booths with minerals, fossils, dinosaurs, meteorites, gems, jewelry, gold, silver, turquoise; special exhibit: The Best of the Best of the Northeast
New Jersey Convention & Exposition Center, 97 Sunfield Avenue, Edison, NJ

April 18–19
Gem, Mineral, and Fossil Show
North Museum of Natural History and Science
Fri. 10–6, Sat. 10–5
Farm and Home Center, 1383 Arcadia Rd (off Manheim Pike) Lancaster, PA
Educational programs, door prizes, food
Contact: Alison Mallin (717-358-7188; amallin@northmuseum.org)

May
Date to be announced:
Ruhl Armory Show
Chesapeake Mineral Club, Baltimore, MD
http://www.chesapeakegemandmineral.org/

May 3–4
Treasures of the Earth: 11th Annual Show and Sale
The Mineralogical Society of Northeastern Pennsylvania, Oblates of St. Joseph, 1880 Highway 315, Pittston, PA

May 17–18
46th Annual World of Gems and Minerals: Gemstone, Jewelry, Bead, Mineral and Fossil Show
Berks Mineralogical Society, Leesport Farmer's Market, Route 61, Leesport, PA

June 7
62nd Semi-Annual Mineralfest
Pennsylvania Earth Sciences Association, Macungie Memorial Park, Poplar Street, Macungie, PA

August 15–17
Gem Miners Jubilee
Fri. 10–6, Sat. 10–6, Sun 10–4; admission: $6
Lebanon Expo Center, Lebanon, PA
http://www.gem-show.com

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Purpose: To promote and encourage interest in and learning about geology, mineralogy, lapidary arts, and related sciences. The club is a member of the Eastern Federation of Mineralogical and Lapidary Societies (EFMLS, http://www.amfed.org/efmls) and the American Federation of Mineralogical Societies (AFMS—at http://www. amfed. org).

Dues: Due by January 1 of each year; $15 individual, $20 family, $6 junior (under 16, sponsored by an adult member).

Meetings: At 7:45 p.m. on the fourth Monday of each month (except May and December)* at **Long Branch Nature Center**, 625 Carlin Springs Road, Arlington, VA 22204. (No meeting in July or August.)

**Changes are announced in the newsletter; we follow the snow schedule of Arlington County schools.*